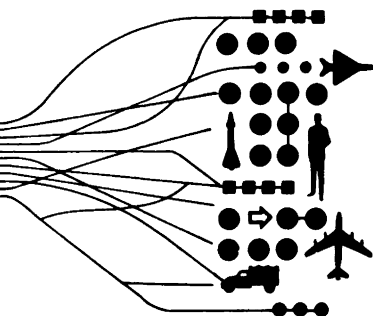


FLEXIBILITY IN INFORMATION RETRIEVAL FOR THE BASE-LEVEL MANAGER

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IN THIS era of decreasing defense expenditures, there is a need to make Air Force operations more efficient. Management information systems contribute to efficient management by providing managers with the information they need to make decisions on the use of the Air Force resources under their control. Information systems should provide specific information, in the format desired, to any manager with a valid need for that information. However, the standard automated data systems (ADS), which are widely used within the Air Force, are inflexible in response to the special information needs of individual base-level managers.

Information *retrieval systems* were designed to provide flexibility in obtaining special information from the standardized systems. However, the diversity in the characteristics possessed by the four major information

retrieval systems currently in use at base level allows only limited degrees of flexibility. The diversity also results in confusion on the part of base-level managers regarding what information they can obtain with a particular retrieval system. The confusion could be resolved by developing a single set of characteristics to be included in each base-level retrieval system. This would simplify the procedure that base-level managers must follow to obtain the individually tailored reports they need to manage Air Force resources more efficiently.

This article is a synthesis of research performed at the School of Systems and Logistics, AFIT, to identify retrieval characteristics that should be included in any information system and to measure the degree to which current Air Force base-level retrieval systems possess these desired characteristics.¹ Flexibility of information retrieval in standardized base-level management information systems may not be a familiar topic to many Air Force managers; therefore, we will present a brief overview of management information systems, system standardization, the need for flexibility, evolution of base-level retrieval systems, and current base-level retrieval systems. A separate discussion of each of these areas will provide a background and understanding of the problem.

management information systems

The Air Force acquired its first general-purpose computer in 1952. Since then its inventory has grown to over 1300 general-purpose computers supported by 23,000 people.² A general-purpose computer is defined as one that is designed to handle a wide variety of problems. Within the Air Force this definition is fulfilled in terms of the massive role computers have played in support of the information requirements of almost every base-level manager. Thus, the

computer's role is to provide information to be used in decision-making. The vehicle for providing this information is commonly referred to as a management information system (MIS).

Definitions of a management information system are as numerous as the authors writing on the subject. A synthesis of definitions indicates that an MIS is simply "a system that collects, processes, and provides management information needed for decisions." But regardless of the definition used, the key element of an MIS is output. This output is in terms of management information. Within the Air Force, the bulk of MIS output is produced by *standard* automated data systems.

system standardization

Current USAF data automation planning concepts have the stated goal of enhancing the accomplishment of mission objectives through the effective and efficient exploitation of computer capability.³ Specifically, one of the data automation planning objectives is to provide "... data systems which are responsive under all conditions to the dynamic needs of commanders and managers. . . ." ⁴ In order to take full advantage of the capabilities of modern electronic computers and provide a common understanding of base-level management systems, the Air Force has undertaken the major project of standardizing computerized data systems.

A standard automated data system is defined as "an automated data system common to two or more commands and possessing *uniform* inputs, file content, processing logic, and outputs."⁵ Standardization in the Air Force means that each user of a standard system will receive basically identically formatted output products. To ensure this standardization, functional systems (e.g., supply, procurement, transportation)

are centrally designed, programmed, and maintained, but they are applied at each Air Force installation that possesses the functional activity for which the system was designed.⁶

"The Secretary [of Defense] emphasized that in the future the development and installation of standard data systems must go far beyond current practices and applied to a much wider range of systems."⁷ The basic assumption is, then, that standardization will be applied increasingly within the Air Force. While the benefits of standardization are high, there is still a need for flexibility in order to satisfy the unique information needs of base-level managers.

need for flexibility

The Air Force Audit Agency has stated:

Both auditors and managers make extensive use of the standard system products to obtain needed information; however, the standard products do not always provide the information needed in a timely and efficient manner. As a result, various utility, inquiry, and selection programs must be available to provide the necessary flexibility in extracting information from the data base.⁸

The key term in this statement is *flexibility*. If the manager has available for his use only those output products (reports and listings) which the centralized design team found to be justified for inclusion in the standard ADS, he may not be able to satisfy nonrecurring information requirements. Flexibility is needed in information retrieval. This flexibility can be provided in the form of utility, inquiry, or selection programs. In this article, these programs collectively will be referred to as a retrieval system. Retrieval systems are thus defined as *computer programs or routines which have the capability to extract specified data from computer storage, reformat or manipulate these data, and output the data*

*in the format specified by the requestor.*⁹

The use of a retrieval system provides the flexibility needed to supplement standard products in rendering nonrecurring management information in a format suitable to the user.¹⁰ In the past, this flexibility has been provided in varying degrees by base-level retrieval systems.

base-level retrieval systems

In the early 1960s, the only method available to the base-level manager to obtain specific management information produced by a given computer system was to search through the reports (listings) produced by that particular computer system. In 1966 the Air Force Audit Agency recognized the computer as an audit tool and developed two retrieval systems for use by auditors in their reviews of the Standard Base Supply System, which used the UNIVAC 1050-II computer system. The two retrieval systems were relatively simple, compared to current programming standards, and they were used almost exclusively by auditors, but they did serve to lay the groundwork for the more sophisticated retrieval systems currently in use by base-level operating managers within the Air Force.

In 1968 the Air Force-wide implementation of the Burroughs 3500 computer system (B3500) brought renewed emphasis to flexibility in information retrieval. The Base Level Military Personnel System incorporated the Direct English Statement Information Retrieval System (DESIRE), a highly sophisticated one, into the standard system for military personnel management. However, this retrieval system could be used only by personnel managers. There still was no single retrieval system, nor was one planned, that could be used to extract information from the data bases of the other systems using the B3500, e.g., transportation, procurement, maintenance, etc.¹¹

In 1970 the Air Force Audit Agency undertook the project of evaluating the retrieval systems used by some of the major public accounting firms in the United States. Their objective was to determine if the retrieval systems used by the public accountants could be economically adapted to Air Force usage. The Air Force procured the Arthur Young Audit Management System in 1971 and reprogrammed it for use as a retrieval system on the B3500. This retrieval system is currently in use and is known as the Air Force Audit Management System (AFAMS).¹²

In the meantime the Air Force Data Systems Design Center was proceeding with the development of the Base Level Inquiry System (BLIS), which could also be used to retrieve information selectively from any system on the B3500 computer. In 1972 the early systems used by auditors were superseded by the more powerful Report Program Generator (RPG) as the flexible retrieval system for use on the UNIVAC 1050-II supply computer. Thus, four retrieval systems were in use by the base-level managers: DESIRE, AFAMS, BLIS, and RPG, each of which we will explain.

- The Base Level Inquiry System (BLIS) is a retrieval system that can extract information from any functional data system which uses the B3500 computer system. A functional system is a management information system that applies to a specific area of management, e.g., aircraft maintenance, transportation, procurement. The B3500 is the general-purpose computer used to process information and produce management reports for most base-level functions with the exception of Base Supply.

- The Air Force Audit Management System (AFAMS) is identical to BLIS in its scope of applications. It too can retrieve information from any data base on the B3500. Although the scope of application

is identical, the rules for use (syntax) and the capabilities of AFAMS and BLIS are quite different.

- Somewhat similar to BLIS in syntax is the Direct English Statement Information Retrieval System (DESIRE), which is also a part of the overall B3500 system. However, DESIRE can only be used to retrieve information from the personnel system. It cannot be used to retrieve management information from any of the other functional systems that use the B3500.

- The Report Program Generator (RPG), also known as Program 009, offers the capability to extract information from the supply system that utilizes the UNIVAC 1050-II computer. Its syntax is considerably different from that of BLIS, AFAMS, and DESIRE, but its capabilities are somewhat similar to all three systems.

Each of these retrieval systems was independently designed, resulting in a diversity of characteristics among the systems. Because of the wide range of characteristics possessed by these four base-level retrieval systems, base-level managers often become frustrated and confused in their efforts to use the systems to satisfy specific information requirements.¹³ A single set of retrieval system characteristics familiar to all managers could simplify the retrieval process and improve the decision process.

the AFIT study

The study performed at AFIT to address the problem was divided into two stages. The first stage of research addressed the question: What characteristics should be included in an Air Force base-level retrieval system? The answer to this question was developed from a review of the literature specifically pertaining to management information systems, information retrieval systems, and audit retrieval systems. Each

potential characteristic identified was evaluated on two basic criteria: (1) the frequency of occurrence in the literature and (2) sound logical argument in terms of relevance to the information needs of base-level managers.

The second stage of research addressed the question: To what extent are the desired characteristics included in each of the four Air Force base-level retrieval systems? This question was answered by reviewing the Air Force manuals that documented the four Air Force base-level retrieval systems. This documentation review was supplemented by an analysis of actual computer outputs of each of the four retrieval systems.

characteristics

Based on the results of the extensive literature review, eight characteristics were found to be desirable for inclusion in an Air Force base-level retrieval system. These eight characteristics are summarized and discussed in turn.

(1) Access each file stored within a computer system as well as the capability to make comparisons simultaneously between two or more files.

File Access. Access is defined as the ability to retrieve data from a computerized storage medium. Data are normally subdivided into files in a given automated data system. These files are maintained on a magnetic storage medium such as magnetic tape, disk, or drum. These media serve much the same purpose as a standard office filing cabinet except that, instead of a clerk removing a file manually from a filing cabinet, computer programs remove the file from the mechanized storage media. In terms of a retrieval system, maximum flexibility can be achieved if the given retrieval system has the capability to access

all files contained on the storage media of a given computer system.

(2) Specify record selection based on these comparisons: less than, greater than, equal to, greater than or equal to, less than or equal to, and not equal to.

Specific Selection Criteria. In using a retrieval system, a manager is interested in obtaining specific information about certain portions of a file. In the case of a military personnel file, the commander may want to know which of his officers have a master's degree. Assuming a single file of military officers with a single personnel record for each officer and no existing retrieval system, a complete manual search of a print-out of these records would have to be made. A flexible retrieval system could provide the commander with a list of only those officers with a master's degree. More specifically, a certain portion of each officer's record would have an area reserved for a code denoting "academic education level." Assuming this code was a 5 for a master's degree, the educational level of each officer would be compared to a 5. If a 5 was present, the name of the officer would be printed out on a computer listing. If a 5 was not present, the record would be ignored. This process would be repeated by the retrieval system until all officers' records had been checked. The 5 used in this example is called a "selection criterion."

Joseph Wasserman, a noted expert, states that the selection criteria should also permit a record to be selected based on the data's exclusion or inclusion within a range of values or equaling exact values.¹⁴ This is normally accomplished by using such logical expressions as "equal to or greater than." For example, educational level could be compared as being "equal to 5," or perhaps "greater than 4 but less than 6."

(3) Form compound record selection criteria based on the AND and OR Boolean logic connectors.

Boolean Logic. The Boolean logic pertains to the algebraic processes formulated by George Boole. Boolean logic provides the capability to form complex conditions for the selection of a record.¹⁵ Thus, Boolean relationships are actually an extension of the specific selection criteria characteristic. More specifically, the retrieval system, by stating such relationships as *AND* or *OR*, permits the creation of compound selection criteria.¹⁶ This type of logic permits a single retrieval to satisfy combinations of two or more conditions simultaneously.

To extend the example used in the previous section, assume a commander was only interested in knowing which company-grade officers had a master's degree. Assume that the codes for these military grades are 01, 02, and 03 respectively. The desired selection criteria have been compounded. The retrieval system must have the capability to accept these multiple criteria. It must be able to retrieve the records of those officers with an educational level equal to 5 *AND* a military grade equal to 01, 02, or 03.

(4) Perform random and interval sampling.

Statistical Sampling. A sample is defined as "... any subset of elements from the universe or one of its populations."¹⁷ Viewing a computerized file as a population, a group of records can be considered a sample or subset of this population. In performing an analysis of a file, a manager may not be interested in evaluating each record in a file. Instead, he might evaluate a subset or portion of the file. But in order to make a statement about the *entire* file, his analysis would have to be based on some statistical method. Statistical sampling, for example, can be particularly useful at base level. Managers could obtain a point estimate and confidence level on the condition of certain records or the operation of functional systems by using a flexible statistical sampling capability.

(5) Perform the mathematical operations of addition, subtraction, multiplication, and division.

Mathematical Operations. In general, a significant portion of the data contained in base-level functional systems is quantitative data. Examples of quantitative data include unit cost, quantity on hand, quantity due in, accounts receivable, accounts payable, quantity shipped, etc. Quantitative data by their very nature lend themselves to mathematical manipulation. For example, to compute the total value of all type A widgets in an inventory, the following computation would be made:

unit cost		quantity		total value
of type A	×	on hand of	=	of type A widgets
widget		type A widget		on hand

Any automated data system that contains quantitative data could be enhanced with the flexibility of a mathematical computation capability included in a retrieval system.

(6) Specify the output format, including sort, control break, line spacing, page ejection, page headings, column headings, sub-totals, and final totals features.

Flexible Output Format. The reader may recall that current Air Force policy is to standardize automated data systems to the maximum extent possible and that standardization implies that each user of a standard system will receive basically identically formatted output products (printed reports). Retrieval systems provide the user with a capability to produce individually tailored outputs without the high cost of programming by conventional methods.¹⁸ The capability to produce individually designed output products is the basic purpose of any retrieval system. The presence of this characteristic provides base-level managers with the capability to obtain management reports suited to their individual needs.

(7) Perform comprehensive edits of the input parameters before processing is begun.

Edits. The precise method of inputting retrieval specifications to the retrieval system is termed the "syntax" of the retrieval system; syntax means, then, rules for using a retrieval system. In order for a retrieval run to be successful, these rules must be followed exactly. A series of edits or syntax checks could be performed by the retrieval system to determine proper syntax. If improper syntax was discovered, the retrieval system should print out a message telling the user exactly what was wrong with the input or what syntax rule was violated. In the absence of such edits, retrieval results would be either nonexistent or unpredictable at best, a process that could waste considerable management time and computer resources.¹⁹

(8) Be used without an extensive knowledge of data processing.

Ease of Use. According to the *EDP Analyzer*, a retrieval system should be designed for use by executive and operating managers, without the need for computer programmers to translate the retrieval request into a computer programming language. Thus, an easily used retrieval system "... is a necessary but not a sufficient condition for the effective use of an MIS by managers."²⁰ Crucial to the effective use of a retrieval system is that the user must understand the contents of the files from which he is retrieving. This knowledge of files does not imply, however, that the user must possess an extensive data processing knowledge. According to Grant McLaughlin, the primary advantage of retrieval systems is the ability of *nonprogrammers* to prepare the retrieval system input parameters.²¹

inclusion in Air Force systems

The extent to which these eight desirable characteristics are included in the four major Air Force base-level retrieval systems

is summarized in the accompanying tabulation. A rating of 1 indicates that the respective retrieval system completely possessed an individual characteristic. Fractional credit was given for partial implementation of a characteristic. The extent to which all eight characteristics are collectively included in each of the four Air Force base-level retrieval systems is indicated by the percentage figure in the last line of the table.

Results of Retrieval System Analysis				
Characteristic	BLIS	AFAMS	DESIRE	RPG
File access	.50	.50	0.00	.50
Specific selection criteria	1.00	1.00	1.00	.67
Boolean logic	1.00	1.00	1.00	0.00
Statistical sampling	.50	.50	0.00	0.00
Mathematical operations	1.00	1.00	.50	1.00
Flexible output format	1.00	1.00	1.00	.50
Edits	1.00	1.00	1.00	0.00
Ease of use	1.00	.33	1.00	0.00
Total rating	7.00	6.33	5.50	2.67
Extent of inclusion	87.500%	79.125%	68.750%	33.375%

Thus, the extent to which the eight characteristics are included in the four Air Force base-level retrieval systems is as follows: BLIS—87%, AFAMS—79%, DESIRE—69%, and RPG—33%. These percentage figures represent the degree of flexibility in each of the four retrieval systems for satisfying the unique information needs of base-level managers. Thus, BLIS provides the greatest flexibility, with RPG providing the least. These relative ratings should be viewed with caution because each characteristic was arbitrarily assigned equal weight. The reader should note that while AFAMS received the second-highest overall rating, it was rated relatively low on the ease-of-use scale. Conversely, DESIRE had a lower overall rating than AFAMS but was considered to be ex-

tremely easy to use. Given a choice between AFAMS and DESIRE, a user would probably choose DESIRE, the system that is easier to use. Ease of use, then, could tend to be the overriding characteristic in the selection of a retrieval system.

The comparison of retrieval systems also revealed some redundancy among them. BLIS and AFAMS, for example, are very similar in both capability and scope of application. Exclusive of the ease-of-use characteristic, these two systems had identical ratings. This is not to say that the two systems are identical in every respect, but it does indicate that their capabilities are generally the same. Additionally, both BLIS and AFAMS were implemented to serve the same purpose: to retrieve information selectively from the data base of any system operated on the Burroughs 3500 computer system. Redundancy, of course, can be costly.

AIR FORCE managers need information to make good decisions concerning the allocation of scarce resources. Standard systems do not provide all the information that is

required. Retrieval systems can provide flexibility for Air Force managers, which would help them to become more efficient.

The problem is threefold: (1) The four Air Force systems possess only limited degrees of flexibility; thus the using managers are limited in what they can obtain. (2) The diversity of abilities possessed by individual systems often causes confusion as to what information is available. (3) There is redundancy between systems in capability and scope of application, which results in needless costs.

The retrieval characteristics identified in this research could be used as a basic point for development of a desired set of characteristics to be included in all existing, as well as future, Air Force information systems. The inclusion of this set would provide added flexibility, reduce redundancy, and, perhaps most important, reduce confusion. It would help Air Force managers to use the costly systems that were designed to provide information for making better decisions and using resources more efficiently.

School of Systems and Logistics, AFIT

Notes

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